AN EVALUATION OF CHEMICAL PROCEDURES FOR DETERMINING THE LIME REQUIREMENT OF SOILS

by

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INTRODUCTION

On certain soils of Southeastern Kansas only part of the actual lime requirement was being determined by the Woodruff buffer solution method of determining lime requirements. In 1961, a new method for determining the lime requirement, the Shoemaker, McLean, and Pratt buffer, was devised in Ohio to determine the lime requirement of soils containing appreciable amounts of extractable aluminum.

It was believed that the amount of extractable aluminum in Southeastern Kansas soils was a principle factor in the partial measurement of lime requirements by the Woodruff buffer method. The Shoemaker, McLean, and Pratt buffer method seemed to have promise in these troubled areas.

There are many methods for determining the lime requirements of soils. However, the two methods mentioned above have shown the most promise to date as rapid methods of adequately determining the lime needs of Kansas soils. In order to determine which of these methods had greater adaptability to Kansas conditions, more knowledge needed to be obtained. The study reported in this thesis was undertaken to evaluate these chemical methods of determining the lime requirement for Kansas soils and to add to the knowledge of this subject.

REVIEW OF LITERATURE

The term pH, as it is generally considered is an expression of the activity of the hydrogen ion. Thus, the pH of a soil is actually an expression of that part of acidity which is present in the equilibrated systems in the form of hydrogen ions regardless of their sources. Since the acidity of the acid-producing ions is not shown in the pH measurement as long as ions stay unhydrolyzed, soils with the same hydrogen ion activity and different amounts of unhydrolyzed aluminum ions may have the same pH (16). Soil pH, therefore, by no means indicates the total acidity which a soil may have and it may not show the amount of lime needed for crop production.

In earlier work, according to Pierre and Worley (13), the reason why soils to which have been added amounts of lime equilivalent to their content of exchangeable hydrogen, do not reach a pH of 7.0 but only of 6.5, is believed to be because the lime reacts with other than the exchangeable hydrogen of the soil.

Many methods of qualitative and quantitative nature have been used for determining suitable lime applications for acid soils (15). Lime requirement studies were the object of much early research with studies by Wheeler (19), Veitch (17), and Hopkins *et al*. (4), being the first attempts at quantitative estimates. Recently this subject has received renewed interest, with emphasis being placed

on the soil factors which give rise to soil acidity and their effects on the lime requirement (7).

The pH of a soil under natural conditions is not absolutely constant, in salt concentration, in organic matter, and in partial pressure of CO_2 (5, 18, 20). Direct titration methods have been proposed and used for the quantitative measurements of soil acidity (3, 13, 15). When compared to changes in reaction brought about by application of lime to soils in the laboratory, in the greenhouse, or in the field, these methods have been found to be only approximately quantitative.

In 1943, I. D. Brown (1), by combining the use of the glass electrode and the concept of depression of the pH of a buffered solution as a measure of exchangeable hydrogen, first introduced a relatively simple and adequately accurate determination of the liming requirement.

The basic concept for determination of the lime requirement of soil involves the use of a solution buffered at a certain pH and of such a character that the pH of the mixture of the soil and solution decreases linearly with respect to the exchangeable hydrogen content of the soil (22). If the buffering capacity of such a solution is large with respect to that of the soil added to the solution, and if the depression of the pH of the solution is restricted to small values, then the depression of the pH mixture of soil and solution approaches an absolute measure of the amount of exchangeable hydrogen in the soil. Following are some

desireable properties of such a buffer mentioned by Woodruff (22):

1. A combination of chemical substances should be chosen that does not react unfavorably with the soil.

2. A rapid rate of reaction is desireable.

3. The results should not be affected appreciably by the nature of the soil.

4. The depression in pH should be in a convenient ratio to the hydrogen content of the soil.

Lime requirement values determined from pH depression of a buffer system when equilibrated with a soil sample (21, 22), have been used by several states. Recently, McLean *et al*. (11), and Shoemaker *et al*. (14), working on Ohio soils, reported a new lime requirement test which utilized a buffer with much weaker buffering characteristics than the Woodruff and a much wider pH range, the titration curve ranging from pH 7.5 to 4.8, while the Woodruff ranged only from 7.0 to 6.0. They developed this buffer after noting that the Woodruff method gave poor results on Ohio soils, especially for soils high in extractable aluminum. Further studies were conducted by Shoemaker *et al*. (14), to determine why certain soil test methods failed to indicate the actual lime requirement in many Ohio soils. For these soils the Woodruff method had indicated only about half the amount of the actual lime requirement.

Yaun (23) stated that hydrogen and aluminum ions are the two main components of soil acidity in most acid soils but their relationships are certainly far more complicated

than a pure solution of the two for it is known that the aluminum ions may also exist in soil in some basic or hydroxyl aluminum forms. In addition, papers by McAuliff and Coleman (9) and Low (8), have reemphasized the results of Paver and Marshall (13), which indicated that acid clays are in reality H-Al clays. The results of a study by Yaun (23), showed that the soil pH was greatly reduced by additions of hydrogen ions. The initial effect of aluminum ions was considerable but subsequent increases in the amount had little effect. When both hydrogen and aluminum ions were present, the hydrogen ions were the dominating factor that determined the pH but aluminum did have an effect on the soil pH when the hydrogen ion concentration was low.

The various kinds of aluminum cations in the soils are acidic to differing degrees and are displaced from the exchange sites of the colloid to varying extents. Therefore, in proportion to the amounts of the different kinds of aluminum present, they are the cause of corresponding fractions of the total acidity, and they complicate the accurate measurement of soil acidity.

At Ohio State University, McLean <u>et al</u>. (11) found that the forms of aluminum present have much to do with the amount of acidity indicated. The initial pH following liming was much higher than the ultimate pH after extended incubation. The pH of the soil was found to reach a maximum at about one to five months and then decrease

gradually. This continuous change in pH was considered by McLean *et al.* (11) to result from the gradual neutralization of the various types of hydroxy-aluminum ions and their precipitation as $Al(OH)_3$ or from the polymerization of the hydroxy-aluminum ions.

EXPERIMENTAL EQUIPMENT

A Beckman Zeromatic pH meter and a Coleman Junior Spectrophotometer were used in this study. The pH measurements were made with a glass electrode. The spectrophotometer was used for the colorimetric determination of aluminum.

EXPERIMENTAL PROCEDURE

Collection and Preparation of Soil Samples

The soil samples were obtained through the cooperation of county agents in selected counties over the state of Kansas. Following is the sampling procedure that was used:

1. Each county agent was asked to send five samples.
2. Some of the samples were to be from acid unlimed soils with low pH's. This was very important in evaluating the problems with the lime test.
3. Samples were to be taken from the surface soil in the same manner as for general fertility tests.
4. The size of the sample was to be one quart.

The soil samples were air dried at room temperature, ground to pass through a 40 mesh sieve, and thoroughly mixed.

Woodruff Buffer Solution

The procedure as outlined by Woodruff (22) was used in preparing the buffer solution. The pH 7 buffer solution containing 8 gm. of p-nitrophenol, 40 gm. of calcium acetate, and 0.62 gm. of magnesium oxide per liter was prepared as follows:

The calcium acetate was dissolved in one-half the total amount of distilled water. The p-nitrophenol was dissolved in slightly less than the other one-half of the distilled water that had been heated to nearly boiling. This solution was stirred until the p-nitrophenol was completely dissolved and then it was added to the calcium acetate solution and mixed thoroughly. The solution was allowed to cool to room temperature, the magnesium oxide was added, and then the solution was made up to the desired volume with distilled water and mixed thoroughly. The pH of the solution was adjusted to 7.00 ± 0.002 by adding dilute HCl or MgO.

The buffering capacity of the solution may be checked by adding sufficient standard acid to supply 0.7 m. e. of hydrogen to 20 ml. of the buffer solution and making the total volume to 30 ml. with water. The resulting solution should have a pH of 6.00 ± 0.02.

Lime Requirement Determination by the Woodruff Buffer Solution

The procedure used was as follows (22):

1. Five grams of soil were weighed into a 1¼ ounce paper cup.
2. Five milliliters of distilled water were added and the mixture was stirred thoroughly with a stirring rod.
3. The mixture was allowed to stand for at least 20 minutes.

4. The mixture was stirred just before immersing the electrodes of the pH meter into the solution.

5. The pH of the soil was read and recorded.

The lime requirement test was not made on soils having pH's of 6.3 or greater since the soil was not considered to be acid enough to benefit from liming. If the soil had a pH of 6.2 or less, a lime requirement test was made. The lime requirement test was made by adding 10 ml. of the Woodruff buffer solution to the soil-water mixture. The mixture was then stirred, and allowed to stand for at least 20 minutes. The mixture was stirred again just before immersing the electrodes and the pH of the soil-buffer suspension was determined. One ton of lime was recommended per acre for every two-tenths of a pH change below pH 7.0. For example, if the pH of the soil-buffer mixture was 6.4 the lime requirement would be 3 tons/acre.

Shoemaker, McLean, and Pratt Buffer Method of Determining Lime Requirement of Soils

The original method proposed by Shoemaker *et al.* (14) was modified slightly for use in this investigation. The modified procedure follows:

I. Preparation of Buffer Solution

Chemical	Quantity Per Liter
Para-nitrophenol	1.8 gm.
Triethanolamine	2.5 ml.
Potassium chromate (K_2CrO_4)	3.0 gm.
Calcium acetate $Ca(CO_2CH_3)$	2.0 gm.
Calcium chloride ($CaCl_2 \cdot 2H_2O$)	53.1 gm.

Mixture was adjusted to pH 7.5 with NaOH or HCl.

II. Testing Procedure Adopted

1. Five grams of soil were weighed into a 1¼ ounce wax paper cup.
2. Five milliliters of distilled water were added.
3. The mixture was stirred and the pH was determined.
4. If the pH reading was 6.5 or above no lime requirement test was made.
5. If the soil-water pH reading was 6.4 or lower, the lime requirement was determined with the buffer solution.
6. Ten milliliters of the buffer solution was added to the soil-water suspension and stirred.
7. The soil-buffer suspension was stirred intermittently for 20 minutes.
8. The pH of the soil-buffer suspension was read immediately.
9. The lime requirement was determined from Table 1.

Table 1. Lime requirement recommendations determined by the Shoemaker, McLean, and Pratt buffer solution.

Soil-buffer pH	Pounds of Effective $CaCO_3$ Recommended per Acre
7.1	1,000
7.0	1,500
6.9	2,000
6.8	2,500
6.7	3,000
6.6	4,000
6.5	5,000
6.4	6,000
6.3	7,500
6.2	8,500
6.1	9,500
6.0	11,000
5.9	12,000
5.8	13,000
5.7	14,000
5.6	15,000
5.5	16,000
5.4	18,000
5.3	19,000
5.2	20,000

Lime Determination by Calcium Hydroxide Titration

A modification of the method used by Dunn (3), involving titration with calcium hydroxide, was used to determine the actual amount of base necessary to raise the soil pH to 7.0. The modified procedure follows:

1. Ten gram samples of soil were placed into a series of 250 ml. Erlenmeyer flasks.
2. Different amounts of 0.04 N $Ca(OH)_2$ were added to the flasks, using 5 ml. as the equivalent of 1 ton of pure $CaCO_3$ per acre.
3. The flasks were diluted to 50 ml. with distilled water.
4. Three drops of toluene were added to prevent microbial activity.
5. The suspensions were allowed to stand in stoppered flasks for 4 days and were thoroughly shaken twice a day.
6. The pH values of the suspensions were recorded.
7. A titration curve was constructed by plotting the pH values on the ordinate and tons of lime per acre on the abscissa (see Appendix).

Extraction of Aluminum

Ten grams of soil were extracted with 100 ml. of solution (11). The detailed procedure follows:

1. The sample was weighed into a suitable Erlenmeyer flask, and 50 ml. of the extracting solution were added.
2. The stoppered flask was shaken thoroughly and allowed to stand over night.
3. The supernatant liquid was filtered through a Whatman No. 42 filter paper.

4. The soil was washed several times with small volumes of the remaining 50 ml. extractant, shaken, and passed through the filter.

5. The total filtrate was made up to 100 ml. volume with the extracting solution.

The extracting solution used was 1 N NH_4OAc (pH 4.8). This extractant was used because of several advantages it has over other extractants. According to work done by McLean *et al*. (11), 1 N NH_4OAc at pH 4.8 extracts enough aluminum from most soils for accurate measurement by the Chenery method (2), yet its action would not be expected to be severe enough to attack the clay lattice. The NH_4OAc was well buffered, compared to neutral salts of strong acids, yet it provided the necessary ionic strength for proper extraction. Also it was relatively free of substances which may interfere with certain colorimetric determinations.

Colorimetric Determination of Aluminum

I. Reagents

Aluminon Reagent (2)--Ammonium aurine tricarboxylate, 0.75 gm.; gum acacia, 15 gm.; ammonium acetate, 200 gm.; concentrated hydrochloric acid (A. R.), 189 ml. The chemicals were dissolved separately, mixed, filtered, and made up to 1500 ml.

Thioglycollic Acid (2)--One ml. was diluted to 100 ml.

Aluminum Standards (6)--Exactly 0.500 gm. of electrolytically prepared metallic Al wire free

from a surface coating of aluminum oxide was dissolved in 15 ml. of 6 N HCl. This solution was then diluted to 1 liter. A dilute standard was prepared by diluting 10 ml. of the first solution to 1 liter, giving 5 ugm. of Al per ml. of solution, and then further dilution of 100 ml. of this solution to 250 ml. to give 2 ugm. of Al per ml. Aliquots (½, 1, 1½, 2, 3, 4, and 5 ml.) of the dilute standard Al solution were taken for the standard curve, and the color was developed as described in the procedure. Optical density was plotted against p.p.m. of Al on graph paper.

II. Procedure

Test solutions containing not more than 8 ugm. of aluminum in 10 ml. of solution were pipetted into Pyrex volumetric flasks graduated at 10 ml. (2). Ten drops or 0.4 ml. of the diluted thioglycollic acid were added and the solutions were mixed. Two ml. of the aluminon reagent were added and the contents of the flasks were made up to 10 ml. and mixed by agitation. The solutions were then heated for exactly 4 minutes in a strongly boiling water-bath and allowed to cool slowly. After 1½ to 2 hours or longer the levels were made up to the mark again, the color was measured in a colorimeter with a 520 mu.

light maximum and reference was made to a standard curve to give ugm. of aluminum per 10 ml. All reagents were quite stable over a period of 6 months and the aluminon lakes, after standing for 1½ hours, remained unchanged for a further 24 hours.

RESULTS AND DISCUSSION

Results of the various analyses on 61 acid soil samples from selected counties in Kansas are shown in Table 2. It should be noted that the pH values of the 1:1 soil-water suspension were in a relatively narrow range of 4.7 to 6.3. While a wider pH range might have been desirable in this type of study, it is difficult to find Kansas agricultural soils which are more acid than pH 4.7. Soils with pH's of 6.3 or higher are not acid enough to be a problem with most common crops. Since the limestone might not have reacted completely in previously limed acid soils, such soils were not included in this study.

The extractable aluminum content of the soils ranged from 0.61 to 2.56 m.e. per 100 gm. of soil. Soils from the Southeastern counties of Kansas, in general, contained more aluminum than did soils from the other areas of Kansas.

The lime requirements determined by $Ca(OH)_2$ titration, used in this study as a check, showed a range of $<$ 1,940 to 9,700 pounds per acre for the different soils. The Woodruff buffer method gave values ranging from 500 to 6,000 pounds per acre. The Shoemaker, McLean, and Pratt buffer method showed the largest range varying from 1,500 to 12,000 pounds per acre. Shoemaker, et al. (14) recommended that a minimum practical application of 2 tons of lime per acre be made for any soil (1 ton for sands) having a pH below 6.5--unless a greater lime requirement was shown by the buffer.

Table 2. Chemical data and comparison of different methods for determining the lime requirements of soils.

County	Sample Number	pH 1:1 Soil-Water Suspension	Extractable Al Content	Lime Requirement SMP	Woodruff	$Ca(OH)_2$ Titration
			m.e./100 gm.	pounds/acre		
Barton	1	5.9	0.29	3,000	2,000	2,880
	14	6.1	0.27	2,500	2,000	1,940
	15	5.5	0.26	4,000	3,000	3,880
	16	6.2	0.29	2,000	2,000	1,940
	18	6.2	0.16	1,500	1,000	1,940
	19	6.3	0.24	1,500	1,000	1,940
	22	5.6	0.24	3,000	2,000	3,120
Bourbon	8414	5.5	1.44	4,000	2,000	2,880
	8433	5.8	0.71	2,500	3,000	3,380
	8436	5.9	1.38	3,000	3,000	3,880
	8437	6.1	0.60	2,500	1,000	1,940
	8457	5.7	1.97	8,500	5,000	7,760
	8458	5.8	0.82	7,500	4,000	6,460
	8460	5.6	1.47	5,000	4,000	4,520
Chautauqua	4	5.7	0.23	4,000	4,000	3.880
	5	6.2	0.42	3,000	3,000	3,220
Cherokee	1	6.1	0.64	2,000	1,000	1,940
	2	4.7	2.56	8,500	4,000	9,700
	3	5.5	1.64	7,500	3,000	5,820
	4	5.6	1.42	3,000	3,000	4,520

Table 2. (Continued)

County	Sample Number	pH 1:1 Soil-Water Suspension	Extractable Al Content	Lime Requirements SMP	Woodruff	$Ca(OH)_2$ Titration
			m.e./100 gm.	pounds/acre		
Coffey	1	5.5	0.42	4,000	2,000	3,880
	2	5.4	0.57	6,000	3,000	4,840
Edwards	3	5.8	0.29	4,000	2,000	2,580
	9	6.2	0.30	2,000	500	<1,940
Finney	27	6.1	0.23	1,500	1,000	1,940
Jefferson	1	6.2	0.77	4,000	1,000	3,220
	A	6.1	0.64	4,000	3,000	4,840
	B	5.7	0.26	5,000	3,000	5,820
Marshall	2	5.9	0.67	3,000	2,000	3,880
	3	5.2	1.27	7,500	4,000	5,820
	4	5.5	1.02	6,000	4,000	3,880
	5	5.3	0.49	5,000	4,000	4,840
	6	5.4	1.22	6,000	5,000	5,820
	7	6.2	0.48	3,000	2,000	2,900
	9	5.6	0.40	3,000	3,000	3,880
	10	5.6	0.61	3,000	3,000	4,660
Neosho	1	5.7	1.62	7,500	5,000	6,460
	2	6.0	0.68	3,000	3,000	3,880
	4	5.5	2.50	12,000	6,000	8,720
	7	5.9	1.67	3,000	3,000	2,880

Table 2. (Concluded)

County	Sample Number	pH 1:1 Soil-Water Suspension	Extractable Al Content	Lime Requirement SMP	Lime Requirement Woodruff	Lime Requirement $Ca(OH)_2$ Titration
			m.e./100 gm.	pounds/acre		
Saline	2	5.7	0.36	3,000	2,000	2,900
	3	5.7	0.27	3,000	2,000	2,900
	5	6.0	0.28	3,000	2,000	3,100
	3048	5.8	0.38	3,000	2,000	3,220
	3052	5.7	0.51	4,000	2,000	2,580
	3056	5.8	0.44	3,000	2,000	2,900
	3067	5.7	0.51	4,000	2,000	3,880
Sumner	440	5.6	0.58	6,000	2,000	6,460
	441	5.8	0.73	5,000	3,000	6,300
	443	6.2	0.27	4,000	1,000	2,900
	444	5.5	0.67	5,000	2,000	4,360
	446	5.4	0.58	7,500	4,000	5,820
	449	6.0	0.64	2,000	1,000	<1,940
	452	5.6	0.41	5,000	2,000	4,360
	454	5.9	0.37	2,500	1,000	2,300
	456	5.7	0.66	4,000	3,000	3,880
Woodson	2	5.7	0.47	2,500	2,000	1,940
	3	5.3	0.69	3,000	2,000	3,380
	5	6.1	0.46	2,000	1,000	1,940
	9	5.5	0.88	6,000	3,000	4,840
	10	6.0	0.69	2,000	2,000	1,940

A modification was made in this study. Lime requirement recommendations were made for all soil-buffer pH readings lower than 7.2. This permitted a more accurate determination of the actual lime requirement of the soils.

Correlation of the Lime Requirements Determined by Buffer Solutions with the Lime Requirement Measured by $Ca(OH)_2$ Titration

The simple linear correlation coefficients between the Woodruff and Shoemaker, McLean and Pratt estimates of lime requirement and the lime requirement determined by $Ca(OH)_2$ titration are shown in Table 3. Both methods show a high correlation with the lime requirement determined by $Ca(OH)_2$ titration (significant at the 1% level). The correlation coefficient for the Woodruff method was 0.76 and for the Shoemaker, McLean, and Pratt method was 0.91. Therefore, the lime requirements determined by the Shoemaker, McLean, and Pratt buffer method were more closely correlated with the values determined by actual titration with $Ca(OH)_2$ than were the values determined by the Woodruff buffer method. The Woodruff buffer method, in general, had a tendency to give lower lime requirements than did the Shoemaker, McLean, and Pratt buffer method or the $Ca(OH)_2$ titration.

Table 3. Linear correlation coefficients between lime requirement determinations by two buffer methods and $Ca(OH)_2$ titration.

Test	Correlation Coefficient
	r
Woodruff buffer method and $Ca(OH)_2$ titration	0.76**
Shoemaker, McLean, and Pratt buffer method and $Ca(OH)_2$ titration	0.91**

**Significant at the 1% level.

Correlation of Lime Requirement Determinations by the Various Tests and Extractable Aluminum

The simple linear correlation coefficients of the lime requirements determined by the various tests with extractable aluminum are presented in Table 4. The correlation coefficients for all three methods were of the same order of magnitude (0.65, 0.69, 0.69) for the Woodruff, Shoemaker, McLean and Pratt, and $Ca(OH)_2$ titration, respectively. The similar correlation coefficients for all three methods with extractable aluminum suggests that factors other than aluminum must account for the difference in lime requirements measured by the various tests.

Table 4. Linear correlation coefficients between lime requirements determined by the various tests and extractable aluminum.

Test	Correlation Coefficient
	r
Woodruff buffer and extractable aluminum	0.65**
Shoemaker, McLean and Pratt buffer and extractable aluminum	0.69**
$Ca(OH)_2$ titration and extractable aluminum	0.69**

**Significant at the 1% level.

CONCLUSIONS

The conclusions from this study can be summarized briefly as follows:

1. The lime requirements determined by the Shoemaker, McLean and Pratt buffer solution method were more closely correlated with the values determined by actual titration with $Ca(OH)_2$ than were the values determined by the Woodruff buffer solution method.
2. The Woodruff buffer solution, in general, had a tendency to give lower results than the Shoemaker, McLean and Pratt buffer solution or the $Ca(OH)_2$ titration.
3. The similar correlation coefficients for all three methods (Shoemaker, McLean and Pratt buffer solution, Woodruff buffer solution, and $Ca(OH)_2$ titration) with extractable aluminum suggested that factors other than aluminum must account for the difference in lime requirements measured by the various tests.

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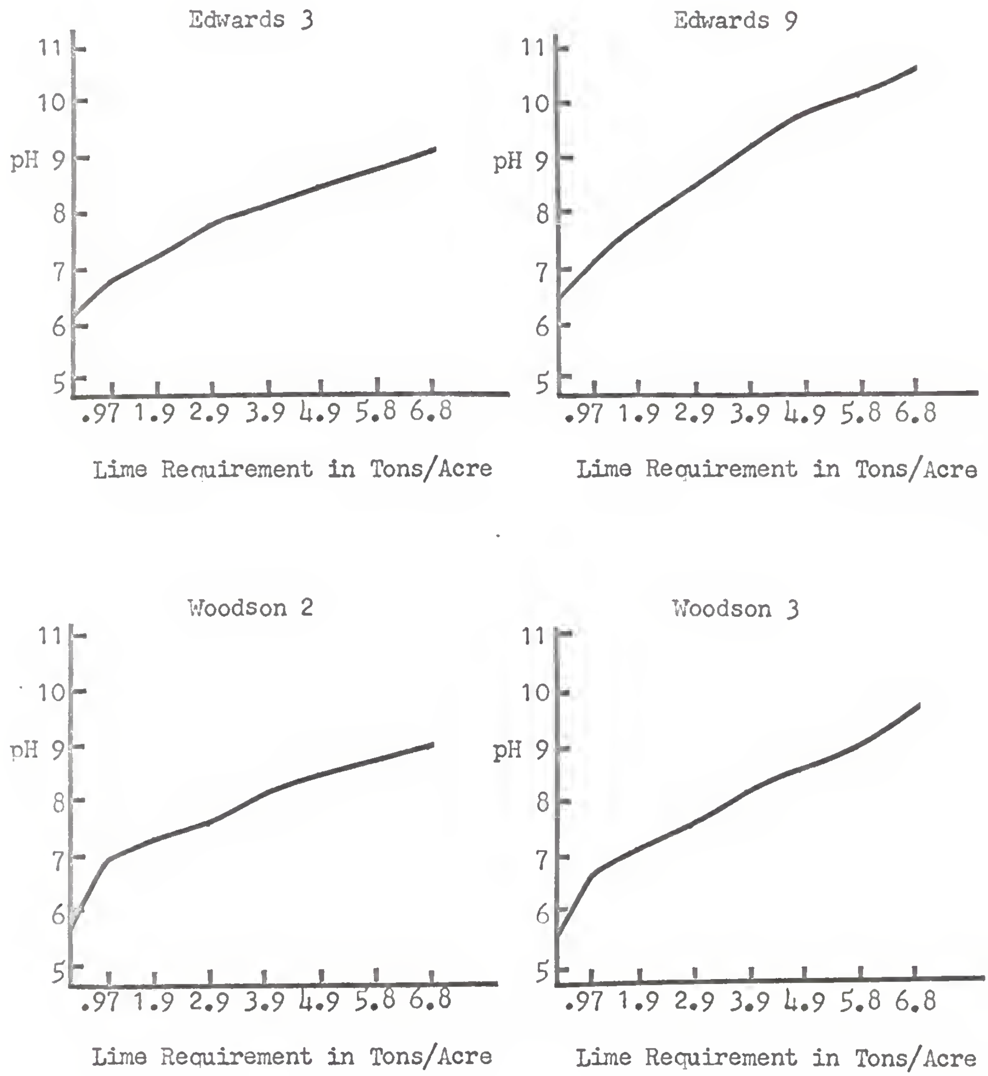
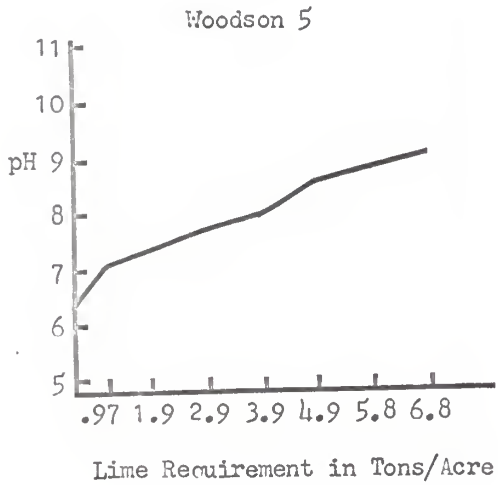
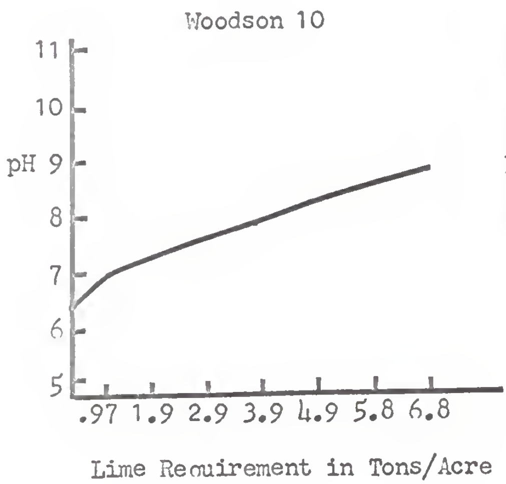
APPENDIX

$Ca(OH)_2$ TITRATION CURVES

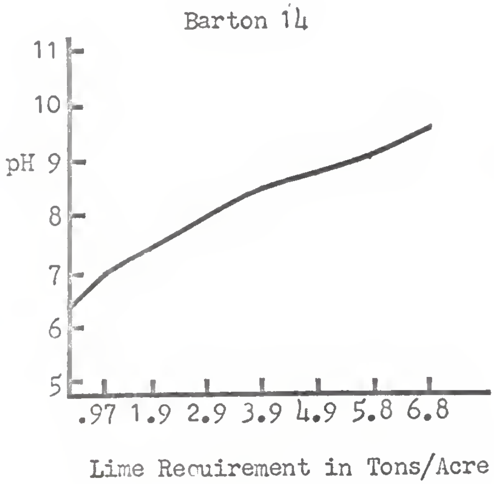


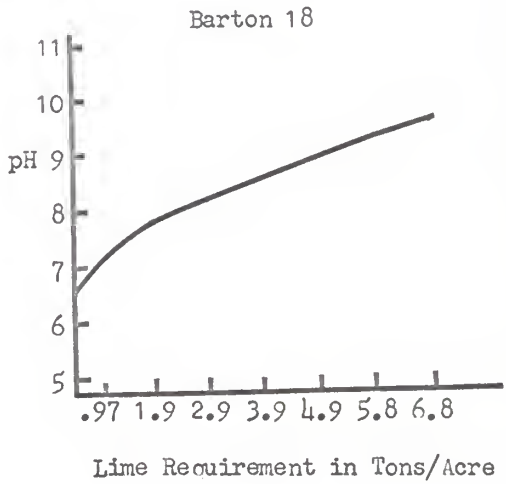
$Ca(OH)_2$ TITRATION CURVES





$Ca(OH)_2$ TITRATION CURVES

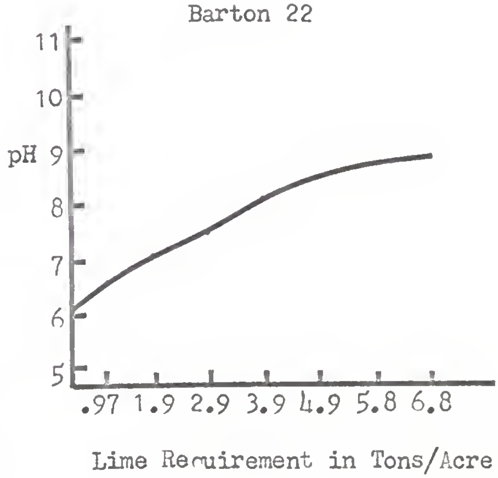




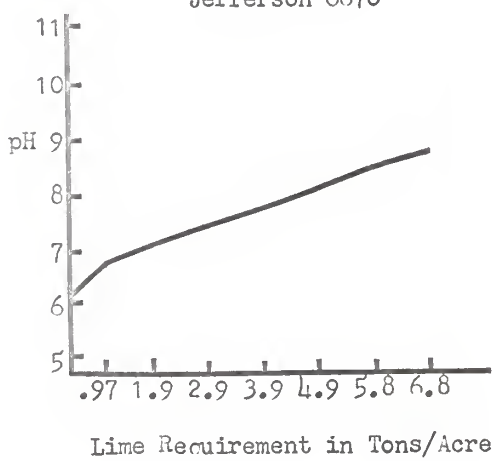
$Ca(OH)_2$ TITRATION CURVES

Barton 19

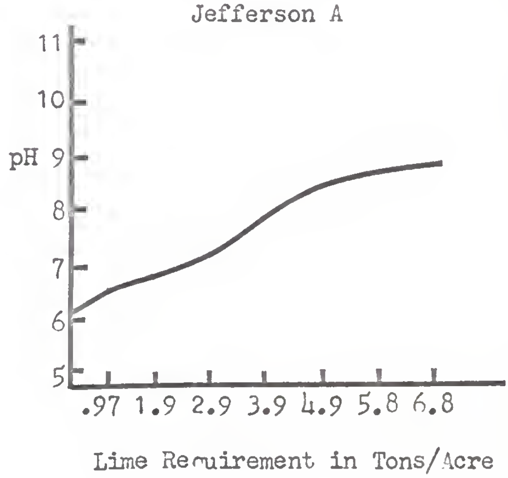
Barton 22



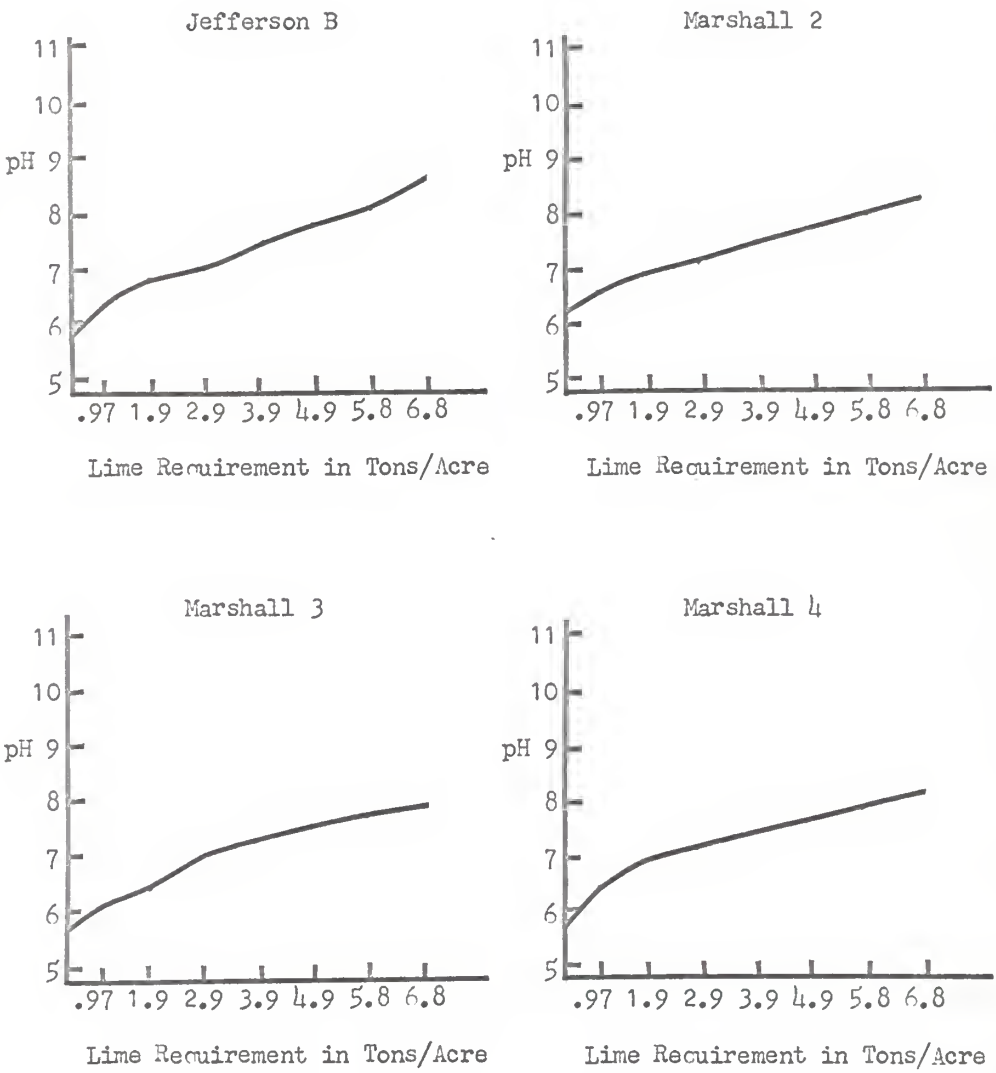
Jefferson 6670



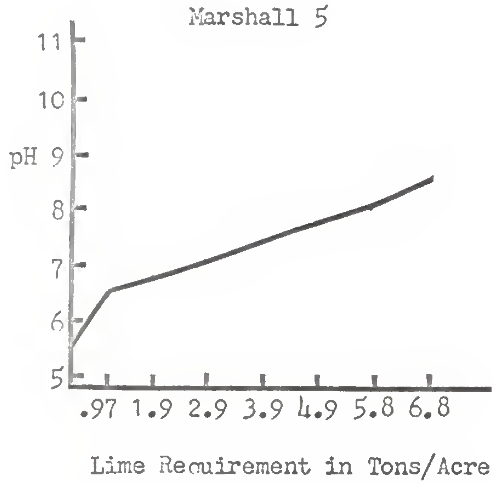
Jefferson A

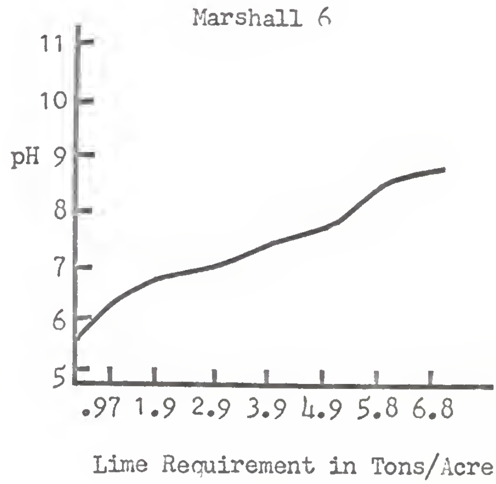


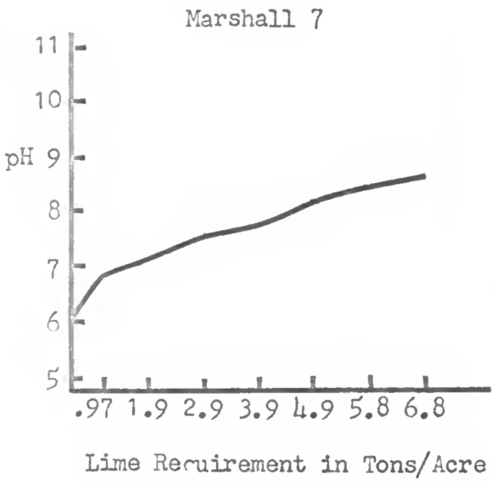
$Ca(OH)_2$ TITRATION CURVES

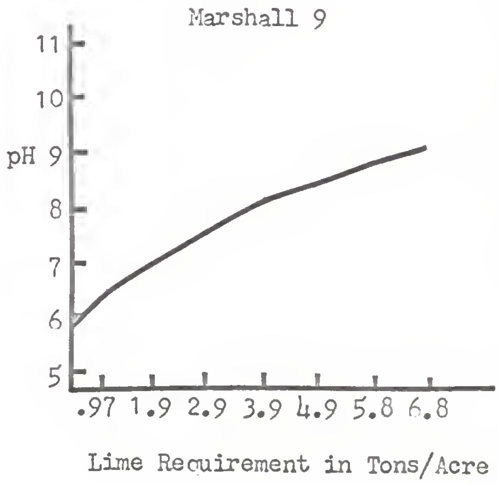


$Ca(OH)_2$ TITRATION CURVES

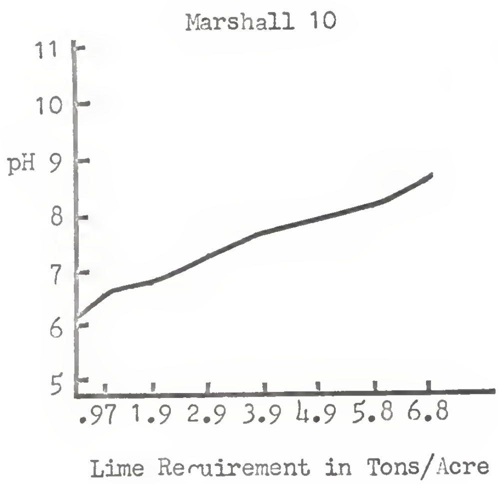


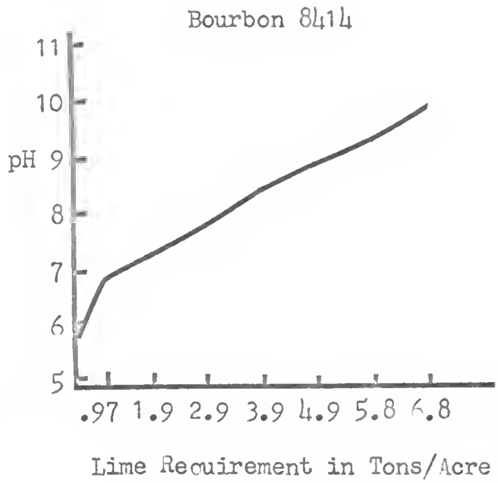


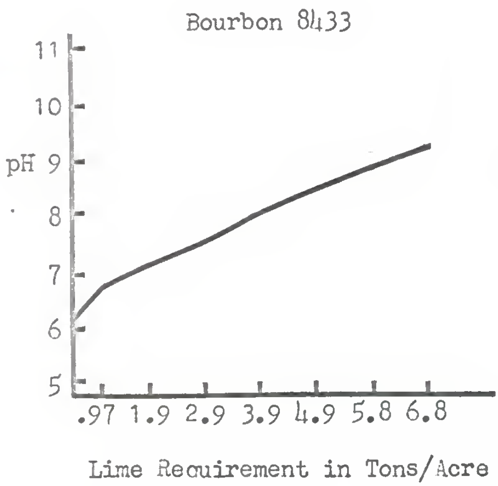


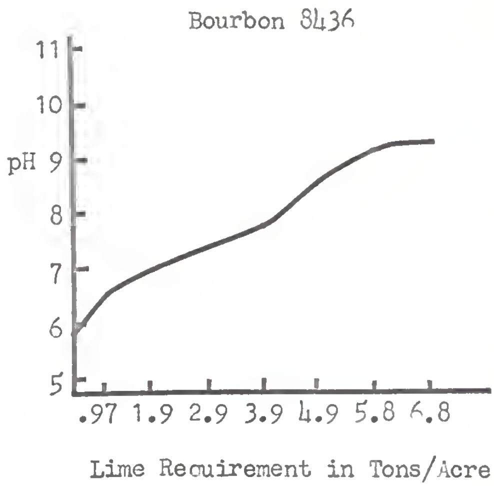


$Ca(OH)_2$ TITRATION CURVES

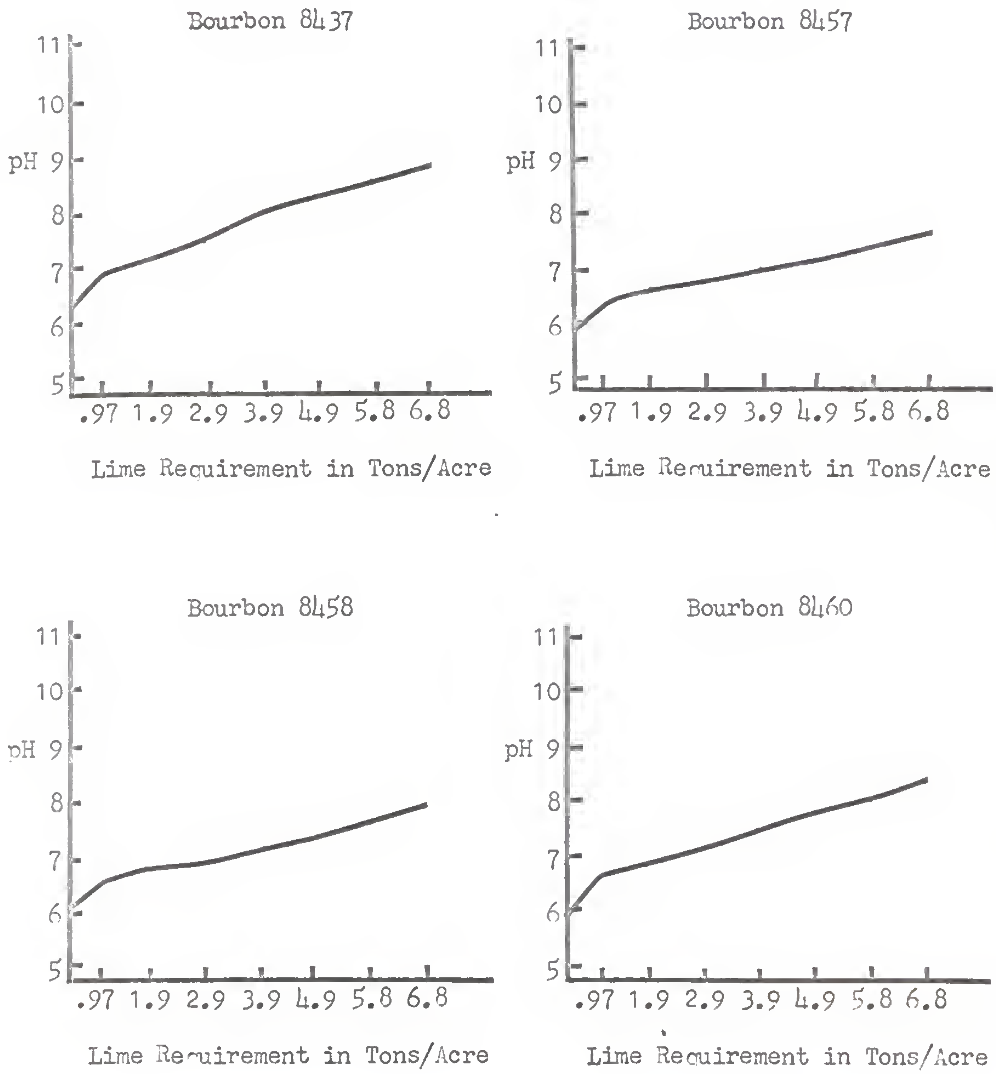






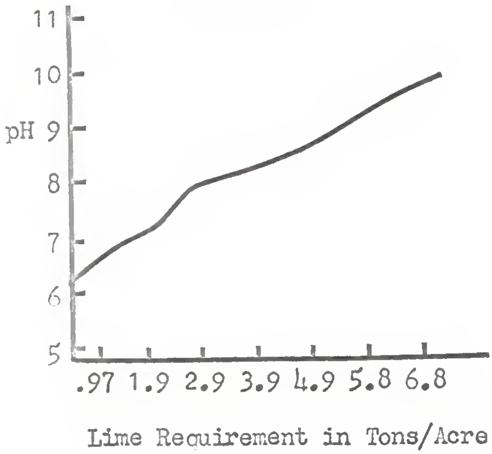


$Ca(OH)_2$ TITRATION CURVES



$Ca(OH)_2$ TITRATION CURVES

Saline 2



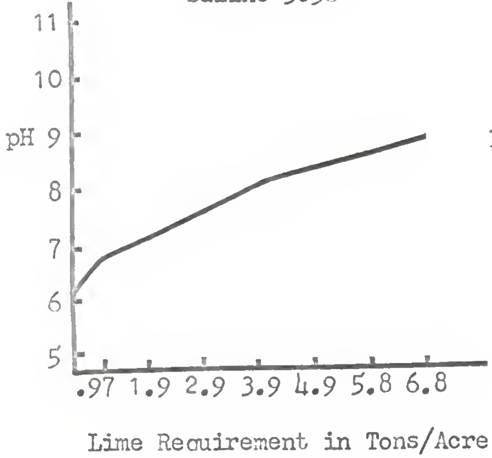
Saline 3

Saline 5

Saline 3052

$Ca(OH)_2$ TITRATION CURVES

Saline 3056



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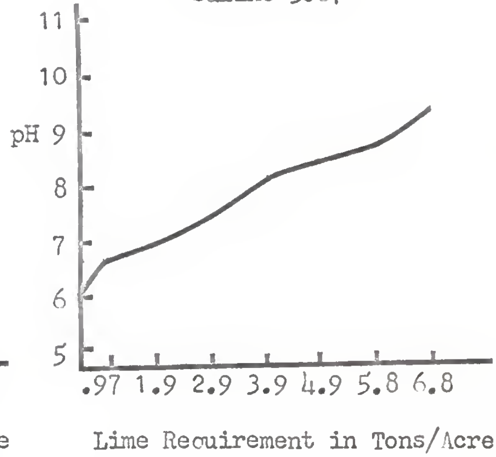

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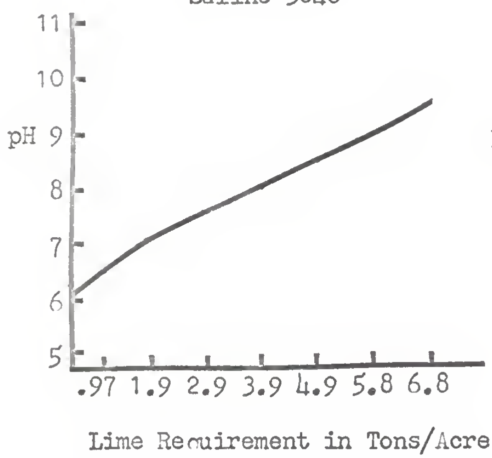
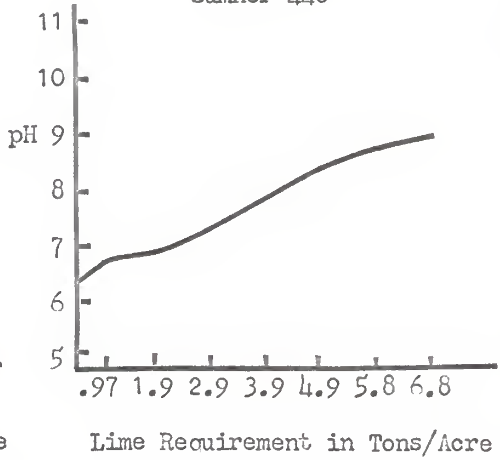
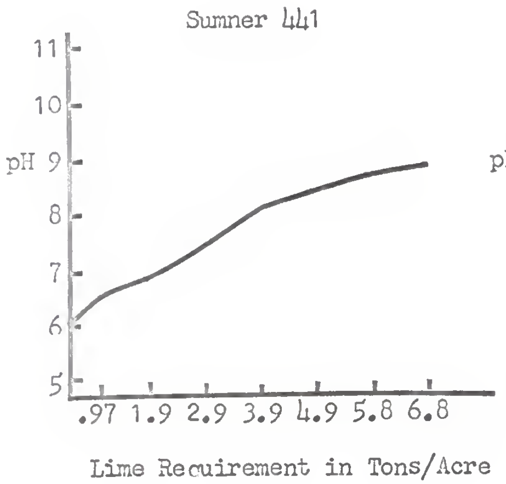
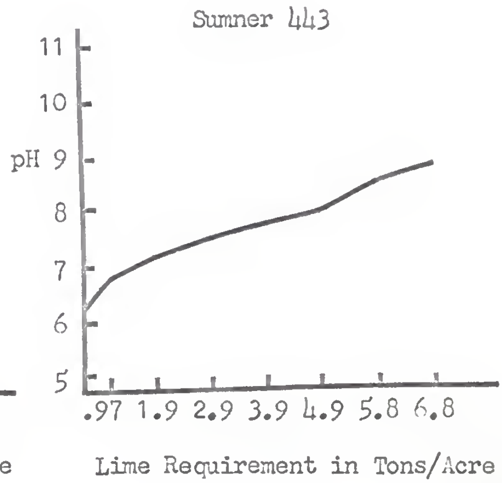


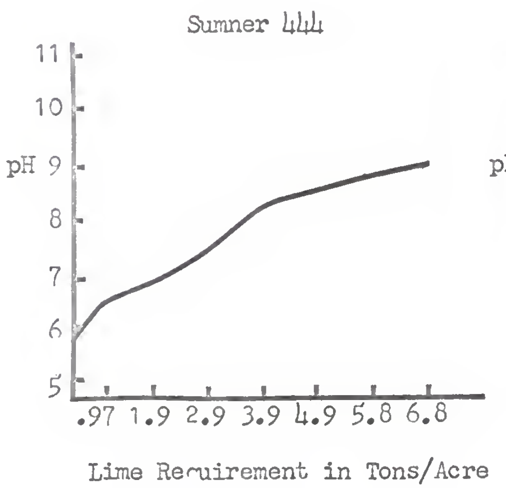
Sumner 440

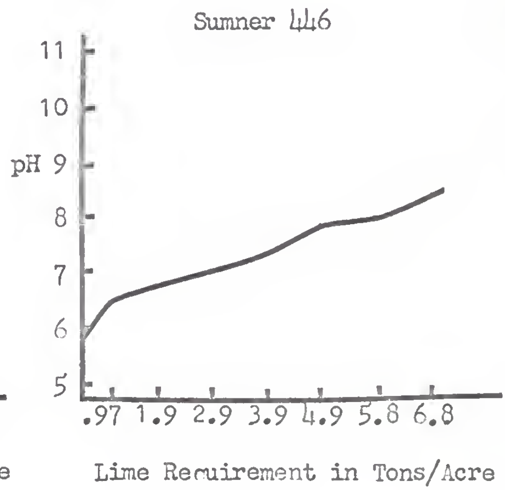


Ca(OH)$_2$ TITRATION CURVES

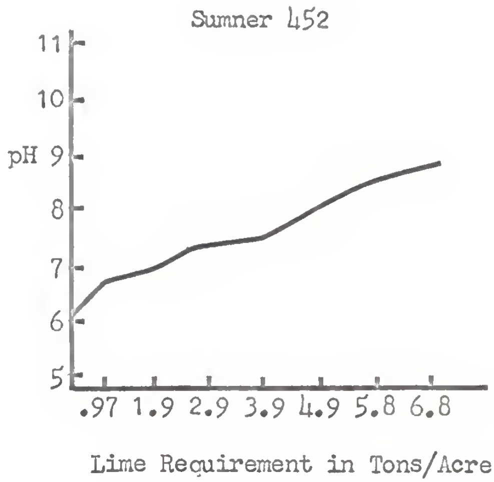


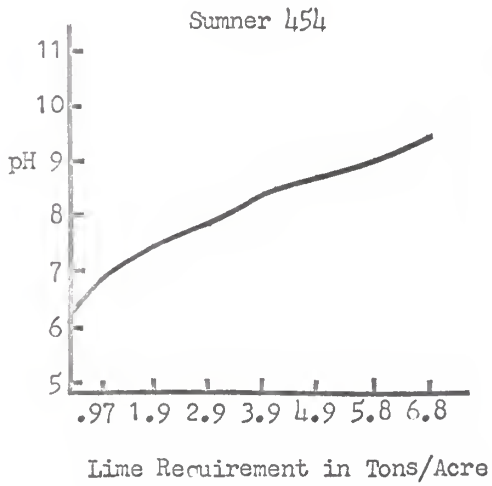






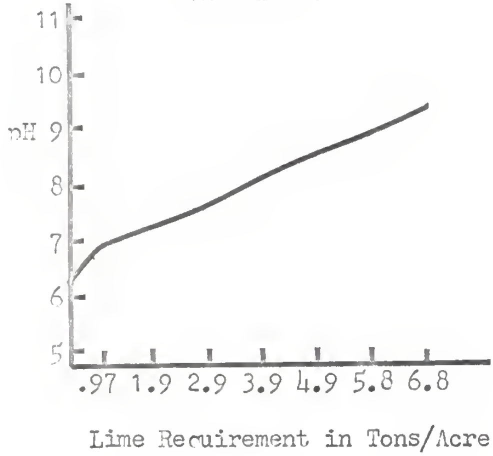
$Ca(OH)_2$ TITRATION CURVES



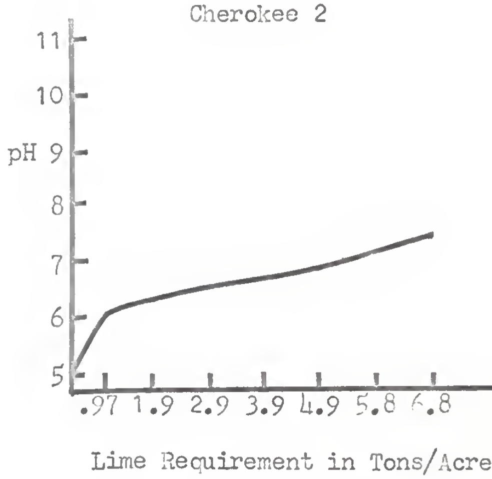


$Ca(OH)_2$ TITRATION CURVES

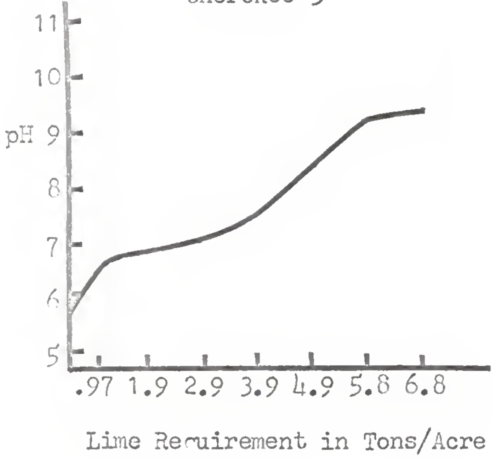
Cherokee 1



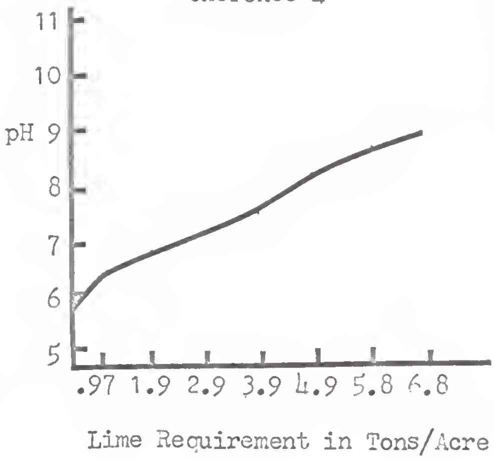
Cherokee 2



Cherokee 3

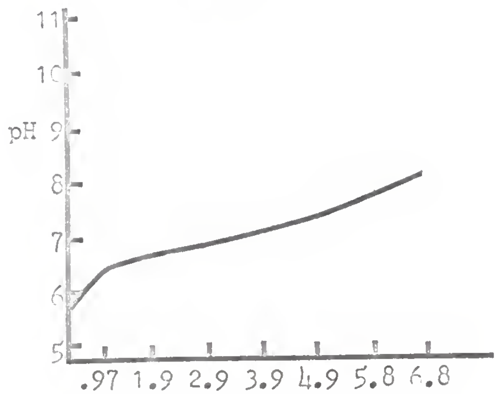


Cherokee 4



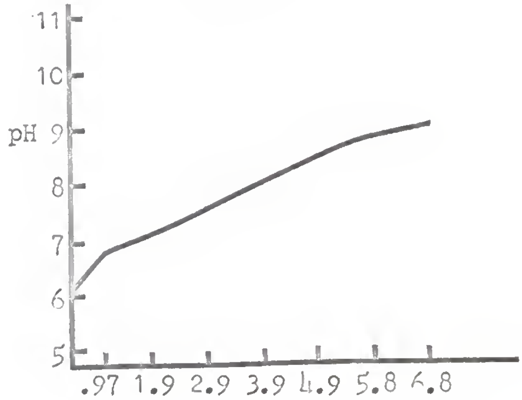
Ca(OH)$_2$ TITRATION CURVES

Neosho 1



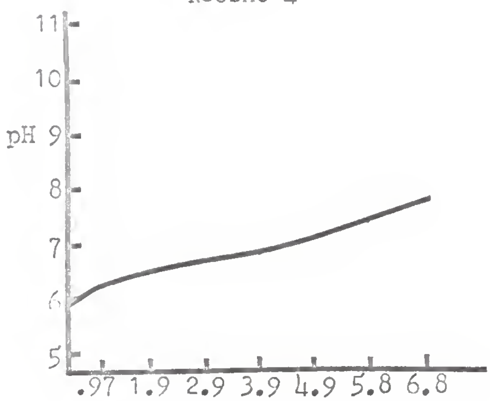
Lime Requirement in Tons/Acre

Neosho 2



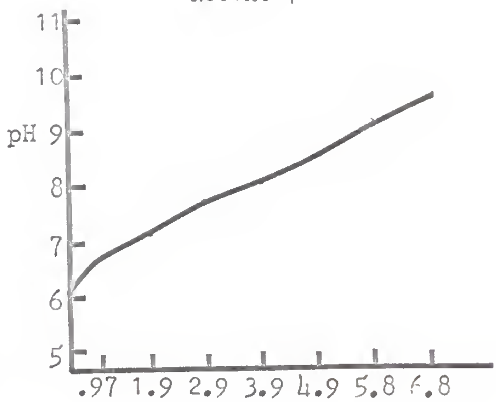
Lime Requirement in Tons/Acre

Neosho 4



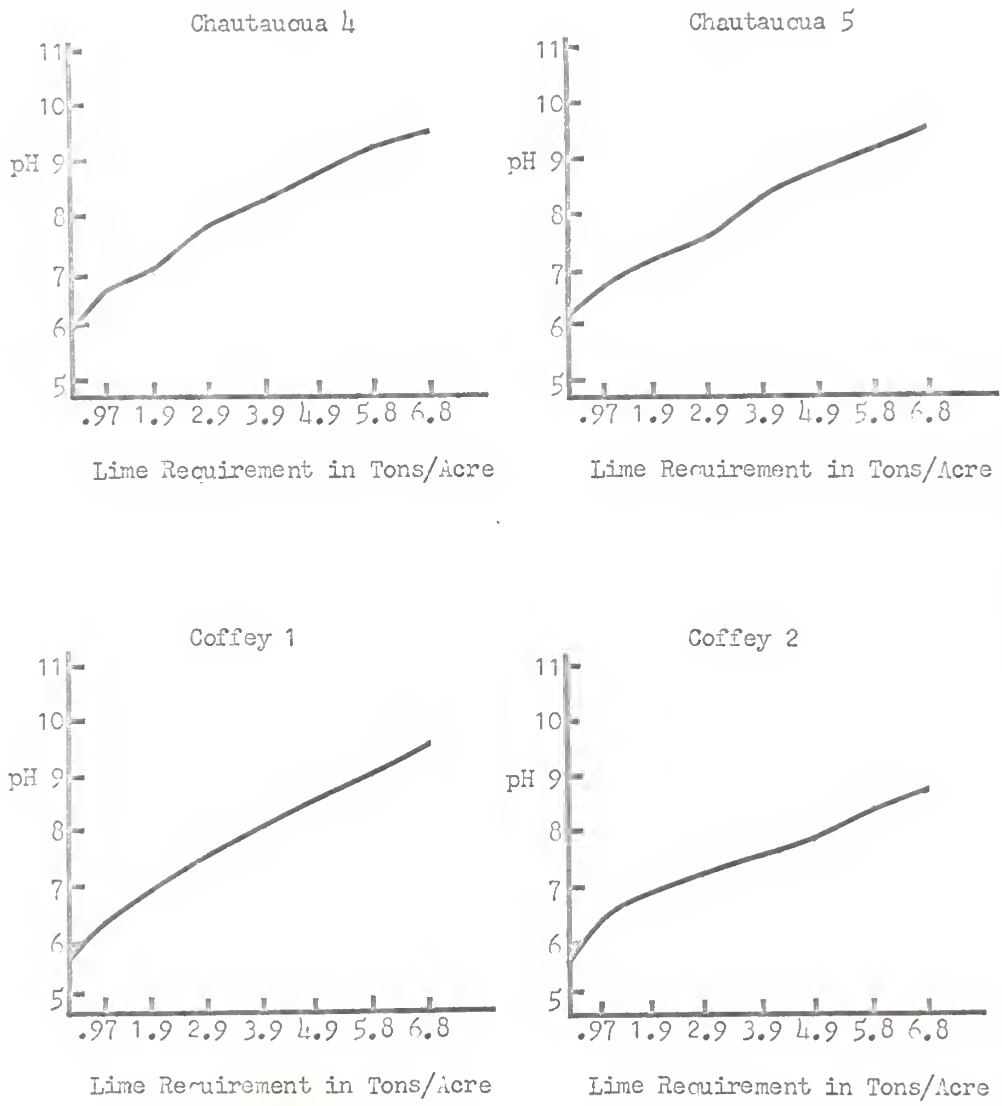
Lime Requirement in Tons/Acre

Neosho 7

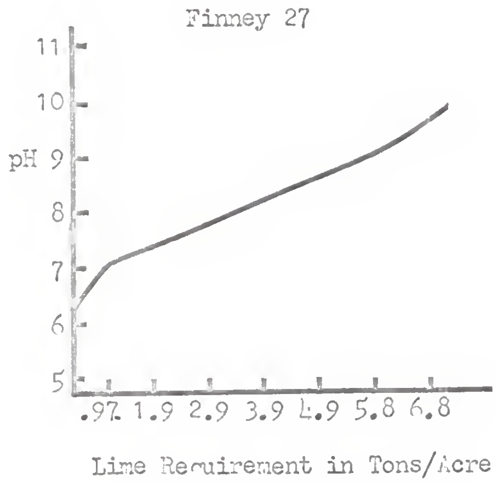


Lime Requirement in Tons/Acre

$Ca(OH)_2$ TITRATION CURVES



$Ca(OH)_2$ TITRATION CURVES



AN EVALUATION OF CHEMICAL PROCEDURES FOR DETERMINING THE LIME REQUIREMENT OF SOILS

by

ROBERT VIT VODRASKA

B. S., Kansas State University, 1965

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

ABSTRACT

The objective of this investigation was to obtain more knowledge about rapid methods for determining the lime requirement of Kansas soils. The Woodruff buffer solution method, which had been used previously in Kansas, measured only part of the actual lime requirement in certain soils. The amount of extractable aluminum was believed to be a factor in the partial measurement of the lime requirement. The Shoemaker, McLean, and Pratt buffer solution, devised in Ohio to determine the lime requirement of soils containing appreciable extractable aluminum, was investigated.

Sixty-one soil samples were collected from selected counties of the state. The lime requirement was estimated by the two buffer solution methods and titration with $Ca(OH)_2$ was used to determine the actual amount of base required to bring the soil to a pH of 7.0. The findings of this study are summarized briefly as follows:

1. The lime requirement values determined by the Shoemaker, McLean, and Pratt buffer solution method were more closely correlated with the values determined by titration with $Ca(OH)_2$ than were the values determined by the Woodruff buffer solution method.
2. The Woodruff buffer solution, in general, had a tendency to give lower lime requirement values than did the Shoemaker, McLean, and Pratt buffer solution or the $Ca(OH)_2$ titration.

3. The similar correlation coefficients for all three methods (Shoemaker, McLean, and Pratt buffer solution, Woodruff buffer solution, and $Ca(OH)_2$ titration) with extractable aluminum suggested that factors other than aluminum must account for some of the difference in lime requirements measured by the various tests.